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Preliminary
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U.S. DEPARTMENT OF TRANSPORTATION

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

LABORATORY TEST PROCEDURE

FOR

FMVSS 126, Electronic Stability Control Systems

ENFORCEMENT
Office of Vehicle Safety Compliance
Room 6111, NVS-220
400 Seventh Street, SW
Washington, DC 20590

OVSC LABORATORY TEST PROCEDURE NO. 126

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REV. No.	DATE	AMENDMENT	EFFECTIVE DATE	
00	Preliminary 04/06/07	72FR17236 04/06/07	6/5/07	Final Rule
01				
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1. PURPOSE AND APPLICATION

The Office of Vehicle Safety Compliance (OVSC) provides contractor laboratories with Laboratory Test Procedures as guidelines for obtaining compliance test data. The data are used to determine if a specific vehicle or item of motor vehicle equipment meets the minimum performance requirements of the subject Federal Motor Vehicle Safety Standard (FMVSS). The purpose of the OVSC Laboratory Test Procedures is to present a uniform testing and data recording format, and provide suggestions for the use of specific equipment and procedures. These Laboratory Test Procedures do not constitute an endorsement or recommendation for use of any product or method. If any contractor views any part of an OVSC Laboratory Test Procedure to be in conflict with a FMVSS or observes deficiencies in a Laboratory Test Procedure, the contractor is required to advise the Contracting Officer's Technical Representative (COTR) and resolve the discrepancy prior to the start of compliance testing.

The OVSC Laboratory Test Procedures are not intended to limit or restrain a contractor from developing or utilizing any testing techniques or equipment, which will assist in procuring the required compliance test data. However, the application of any such testing technique or equipment is subject to prior approval of the COTR.

NOTE: The OVSC Laboratory Test Procedures, prepared for the limited purpose of use by independent laboratories under contract to conduct compliance tests for the OVSC, are not rules, regulations or NHTSA interpretations regarding the meaning of a FMVSS. The Laboratory Test Procedures are not intended to limit the requirements of the applicable FMVSS(s). In some cases, the OVSC Laboratory Test Procedures do not include all of the various FMVSS minimum performance requirements. Recognizing applicable test tolerances, the Laboratory Test Procedures may specify test conditions that are less severe than the minimum requirements of the standard. In addition, the Laboratory Test Procedures may be modified by the OVSC at any time without notice, and the COTR may direct or authorize contractors to deviate from these procedures, as long as the tests are performed in a manner consistent with the standard itself and within the scope of the contract. Laboratory Test Procedures may not be relied upon to create any right or benefit in any person. Therefore, compliance of a vehicle or item of motor vehicle equipment is not necessarily guaranteed if the manufacturer limits its certification tests to those described in the OVSC Laboratory Test Procedures.

2. GENERAL REQUIREMENTS

FMVSS No. 126 establishes performance and equipment requirements for Electronic Stability Control (ESC) Systems installed in motor vehicles. The purpose of this standard is to reduce the number of deaths and injuries that result from crashes in which the driver loses directional control of the vehicle. It is applicable to passenger cars, multipurpose passenger vehicles, trucks and buses with a gross vehicle weight rating of 4,536 kilograms or less, according to the phase-in schedule shown below.

PHASE-IN REQUIREMENTS

Manufacturer Type	Percentage Complying[1]	Period of Production Vehicles Manufactured:
Large Volume	≥ 55%	On or after September 1, 2008 and before September 1, 2009
	≥ 75%	On or after September 1, 2009 and before September 1, 2010
	≥ 95%	On or after September 1, 2010 and before September 1, 2011
	100%	On or after September 1, 2011
Small Volume[2]	0%	On or after September 1, 2008 and before September 1, 2011
	100%	On or after September 1, 2011
Final-stage and Alterers[3]	0%	On or after September 1, 2008 and before September 1, 2012
	100%	On or after September 1, 2012

Vehicles to which this standard applies must be equipped with an ESC system that is capable of applying brake torques individually to all four wheels and has a control algorithm that utilizes this capability, is operational during all phases of driving including acceleration, coasting, and deceleration (including braking), except when the driver has disabled ESC, the vehicle speed is below 15 km/h (9.3 mph), or the vehicle is being driven in reverse, and remains capable of activation even if the antilock brake system or traction control system is activated. Vehicles to which this standard applies must meet specific lateral stability and responsiveness performance requirements.

[1] The percentage complying requirement is calculated as follows: number of complying vehicles in the period of production / either (total number in that period) or (average production in 3 previous periods) x 100.

[2] Produced fewer than 5,000 vehicles for the U.S. market, September 1, 2008 – August 31, 2011.

[3] See 49 CFR 567, Certification.

Yaw rate thresholds are used to assess a vehicle's lateral stability. At 1.0 second after completion of a required sine with dwell steering input, the yaw rate of a vehicle must not exceed 35 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks during the same test run). At 1.75 seconds after completion of a required sine with dwell steering input, the yaw rate of the same vehicle must not exceed 20 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks during the same test run).

Lateral displacement is used to assess a vehicle's responsiveness. The lateral displacement of the vehicle center of gravity with respect to its initial straight path must be at least 1.83 m (6 feet) for vehicles with a GVWR of 3,500kg (7,716 lb) or less, and 1.52 m (5 feet) for vehicles with a GVWR greater than 3,500 kg (7,716 lb) when computed 1.07 seconds after the Beginning of Steer (BOS).

An ESC system malfunction indicator is required.

IN-HOUSE COMPLIANCE TEST PROCEDURE

Prior to conducting any compliance tests, contractors are required to submit a detailed in-house compliance test procedure to the COTR which includes:

A. A step-by-step description of the methodology to be used and detailed check-off lists, including all requirements and test procedures in FMVSS 126, that will be used for testing and data review.

B. A complete listing of test equipment with instrument accuracy and calibration dates.

C. A written Quality Control (QC) Procedure which shall include calibrations, the data review process, report review, and the people assigned to perform QC on each task.

Approval must be obtained from the COTR before commencing testing so that all parties are in agreement. There shall be no contradiction between the OVSC Laboratory Test Procedure and the contractor's in-house test procedure.

METRIC SYSTEM OF MEASUREMENT

As a general rule, use of the metric system of weights and measures is preferred. Performance parameters and test conditions in FMVSS are now specified in metric units. In this Laboratory Test Procedure metric values may be followed by English units only for reference (not necessarily equal). If test equipment is not available for direct measurement in metric units, the test laboratory shall calculate the exact metric equivalent by means of a conversion factor carried out to at least five significant digits before rounding consistent with the specified metric requirement. Metric units shall be used in the Final Test Reports.

TEST DATA LOSS

A compliance test is not to be conducted unless all of the various test conditions specified in the applicable OVSC Laboratory Test Procedure have been met. Failure of a contractor to obtain the required test data and to maintain acceptable limits on test parameters in the manner outlined in the applicable OVSC Laboratory Test Procedure may require a retest at the expense of the contractor. The retest costs will include all costs associated with conducting the retest.

The Contracting Officer of NHTSA is the only NHTSA official authorized to notify the contractor that a retest is required. The retest shall be completed within two (2) weeks after receipt of notification by the Contracting Officer that a retest is required. If a retest is conducted, no test report is required for the original test.

3. SECURITY

The contractor shall provide appropriate security measures to protect the OVSC test vehicles and parts during the entire compliance test program. The contractor is also financially responsible for any acts of theft and/or vandalism that occur during the storage of test vehicles. Security problems that arise shall be reported by telephone to the COTR and the Industrial Property Manager (IPM), Office of Contracts and Procurement, within two working days after the incident. A letter containing specific details of the security problem shall be sent to the IPM (with copy to the COTR) within 4 working days. The contractor shall protect and segregate all photographs and data that evolve from compliance testing. No information concerning the vehicle safety compliance test program shall be released to anyone except the COTR, unless specifically authorized by the COTR or the COTR's Branch or Division Chief.

NOTE: NO INDIVIDUALS, OTHER THAN CONTRACTOR PERSONNEL DIRECTLY INVOLVED IN THE COMPLIANCE TESTING PROGRAM, SHALL BE ALLOWED TO WITNESS ANY VEHICLE COMPLIANCE TEST UNLESS SPECIFICALLY AUTHORIZED BY THE COTR.

4. GOOD HOUSEKEEPING

Contractors shall maintain the entire vehicle compliance testing area, test fixtures and instrumentation in a neat, clean and painted condition with test instruments arranged in an orderly manner consistent with good test laboratory housekeeping practices.

5. TEST SCHEDULING AND MONITORING

The contractor shall submit a test schedule to the COTR prior to conducting the first compliance test. Tests shall be completed as required in the contract. Scheduling shall be adjusted to permit sample motor vehicles to be tested to other FMVSS as may be required by the OVSC. All testing shall be coordinated with the COTR to allow monitoring by the COTR or OVSC personnel if desired.

6. TEST DATA DISPOSITION

The contractor shall make all vehicle preliminary compliance test data available to the COTR on location within four hours after the test. Final test data, including digital printouts and computer generated plots (if applicable), shall be furnished to the COTR within 5 working days. Additionally, the contractor shall analyze the preliminary test results as directed by the COTR. All backup data sheets, strip charts, recordings, plots, technician's notes, etc., shall be either sent to the COTR or destroyed at the conclusion of each delivery order, purchase order, etc.

7. GOVERNMENT FURNISHED PROPERTY (GFP)

ACCEPTANCE OF TEST VEHICLE

The Contractor has the responsibility of accepting each test vehicle whether delivered by a new vehicle dealership or another vehicle transporter. In both instances, the contractor acts in the OVSC's behalf when signing an acceptance of the test vehicle delivery. When a vehicle is delivered, the contractor must check to verify the following:

A. All options listed on the "window sticker" are present,

B. Tires and wheels are new and the same as listed,

C. There are no dents or other interior or exterior flaws,

D. The vehicle has been properly prepared and is in running condition,

E. Owner’s manual, warranty document, consumer information, and extra set of keys are present, and

F. Proper fuel filler cap is supplied on the test vehicle.

A Vehicle Condition form will be supplied to the contractor when the test vehicle is transferred from the new vehicle dealership or between test contracts. The contractor must complete a Vehicle Condition form for each vehicle and deliver it to the COTR with the Final Test Report or the report will NOT be accepted for payment.

NOTIFICATION OF COTR

The COTR must be notified within 24 hours after a vehicle has been delivered. In addition, if any discrepancy or damage is found at the time of delivery, a copy of the Vehicle Condition form shall be sent to the COTR immediately.

8. CALIBRATION OF TEST INSTRUMENTS

Before the contractor initiates the safety compliance test program, a test instrumentation calibration system will be implemented and maintained in accordance with established calibration practices. The calibration system shall include the following as a minimum:

A. Standards for calibrating the measuring and test equipment will be stored and used under appropriate environmental conditions to assure their accuracy and stability.

B. All measuring instruments and standards shall be calibrated by the contractor, or a commercial facility, against a higher order standard at periodic intervals NOT TO EXCEED TWELVE (12) MONTHS! Records, showing the calibration traceability to the National Institute of Standards and Technology (NIST), shall be maintained for all measuring and test equipment.

C. All measuring and test equipment and measuring standards will be labeled with the following information:

(1) Date of calibration

(2) Date of next scheduled calibration

(3) Name of the technician who calibrated the equipment

D. A written calibration procedure shall be provided by the contractor which includes as a minimum the following information for all measurement and test equipment:

(1) Type of equipment, manufacturer, model number, etc.

(2) Measurement range

(3) Accuracy

(4) Calibration interval

(5) Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)

E. Records of calibration for all test instrumentation shall be kept by the contractor in a manner which assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COTR. The calibration procedure must be approved by the COTR before the test program commences.

Further guidance is provided in the International Standard ISO 10012-1, “Quality Assurance Requirements for Measuring Equipment” and American National Standard ANSI/NCSL Z540-1, “Calibration Laboratories and Measuring and Test Equipment - General Requirements.”

NOTE: In the event of a failure to meet the standard’s minimum performance requirements, additional calibration checks of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration will be at the COTR’s discretion and will be performed without additional cost.

9. SUGGESTED TEST EQUIPMENT

A. Portable tire pressure gage with an operating pressure of at least 700kPa (100 psi), graduated increments of 1 kPa (0.1 psi) and an accuracy of at least $\pm$ 2.0% of the applied pressure.

B. Platform scales to measure individual wheel, axle and vehicle loads. Platform scales shall have a maximum graduation of 1 kg (0.5 lb) and have an accuracy of at least $\pm$ 1% of the measured reading.

C. Automated steering machine with steering angle encoder for controlling steering wheel angle input and output. Automated steering machine is used to generate steering inputs for all test maneuvers. The automated steering machine shall be capable of supplying steering torques between 40 to 60 Nm (29.5 to 44.3 lb-ft). The steering machine must be able to apply these torques when operating with steering wheel velocities up to 1200 deg/sec. The steering machine must be able to move the vehicle's steering system through its full range, accept vehicle speed sensor feedback input to initiate steering programs at a preset road speeds, and have the convenience of changing the steering program during test sessions. Handwheel angle resolution is 0.25 deg and accuracy is ± 0.25 deg (ATI Model Spirit 3 or equivalent).

D. Multi-Axis Inertial Sensing System for measuring longitudinal, lateral and vertical accelerations as well as roll, yaw and pitch rates. Accelerometer range ± 2g, resolution ≤ 10µg, and accuracy ≤ 0.05% of full range. Angular rate sensors range ± 100 deg/sec, resolution ≤ 0.004 deg/sec and accuracy 0.05% of full range (BEI Motion PAK or equivalent).

E. Radar speed sensor with dashboard display for vehicle speed with a range of 0-125 mph, resolution .009 mph and accuracy ± .25% of full scale (DEUTA- WERKE Model DRS-6 or equivalent).

F. Two ultrasonic distance measuring system sensors, to determine vehicle displacements that will be used to calculate roll angle, with a range of 5-24 inches, resolution 0.01 inches and accuracy ± .25% of maximum distance (MASSA Model M-5000/220 or equivalent).

G. Data acquisition system to record time, velocity, distance, lateral, longitudinal and vertical accelerations, roll, yaw and pitch rates, and steering wheel angles from vehicle installed sensors. All data is to be sampled at 200 Hz. Signal conditioning must consist of amplification, anti-alias filtering, and digitizing. Amplifier gains are selected to maximize the signal-to-noise ratio of the digitized data. Filtering is performed with two-pole low-pass Butterworth filters with nominal cutoff frequencies selected to prevent aliasing. The nominal cutoff frequency is 15 Hz (calculated breakpoint frequencies are 18 and 19 Hz for the first and second poles respectively).

H. Load Cell to monitor brake pedal force with a range of 0-300 lb and accuracy ± .05% full scale (interface Model BPL 300 or equivalent).

I. Outriggers must be used for testing trucks, multipurpose passenger vehicles, and buses. Vehicles with a baseline weight under 2,722 kg (6,000 lbs) must be equipped with "standard" outriggers and vehicles with a baseline weight equal to or greater than 2,722 kg (6,000 lbs) must be equipped with “heavy” outriggers. A vehicle’s baseline weight is the weight of the vehicle delivered from the dealer, fully fueled, with a 73 kg (160 lb) driver. Standard outriggers shall be designed with a maximum weight of 32 kg (70 lb) and a maximum roll moment of inertia of 35.9 kg-m^2 (26.5 ft-lb-sec^2). Heavy outriggers shall be designed with a maximum weight of 39 kg (86 lb) and a maximum roll moment of inertia of 40.7 kg-m^2 (30.0 ft-lb-sec^2) (NHTSA titanium outrigger system, Docket No. NHTSA 2007-XXXX, Month 200X, or equivalent).

J. Real time digital video camera for documenting sine with dwell maneuver (Sony Model DCR-TRV950 or equivalent).

10. PHOTOGRAPHIC DOCUMENTATION

Photographs for final test reports shall be 8 x 10 or 8-1/2 x 11 inch color prints or digital photographs properly focused for clear images of the intended features. A label or placard identifying the test vehicle make and model, NHTSA number, and date (as a minimum) shall appear on each photograph page and be legible. In addition, each photograph shall be labeled as to the subject matter in the contractor’s Final Test Report. As a minimum, the following photographs shall be included:

A. 3/4 frontal view from left side of vehicle
B. Vehicle Certification Label
C. Vehicle Placard (titled, “Tire and Loading Information”)
D. Tire Inflation Pressure Label (optional label if provided)
E. Close-up view of ESC Malfunction Telltale
F. Close-up view of “ESC OFF” Telltale (if provided)
G. Close-up view of ESC off control (if provided)
H. Close-up view(s) of test instrumentation mounted on outside of vehicle
I. Close-up view(s) of test instrumentation mounted on inside of vehicle
J. Close-up view of tire/rim and track as appropriate depicting rim-to-pavement contact or tire debeading (if present)
K. View of loss of pavement contact of tire(s) as documented by video camera (if present)
L. Any other damage or apparent test failure that cannot be seen in the above photographs.

11. DEFINITIONS

ACKERMAN STEER ANGLE
The angle whose tangent is the wheelbase divided by the radius of the turn at a very low speed.

ELECTRONIC STABILITY CONTROL SYSTEM
A system that has all the following attributes: (1) That augments vehicle directional stability by applying and adjusting the vehicle brake torques individually to induce a correcting yaw moment to a vehicle; (2) That is computer controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer; (3) That has a means to determine the vehicle's yaw rate and to estimate its side slip or side slip derivative with respect to time; (4) That has a means to monitor driver steering inputs; (5) That has an algorithm to determine the need, and a means to modify engine torque, as necessary, to assist the driver in maintaining control of the vehicle, and (6) That is operational over the full speed range of the vehicle (except at vehicle speeds less than 15 km/h (9.3 mph) or when being driven in reverse).

LATERAL ACCEL1ERATION
The component of the vector acceleration of a point in the vehicle perpendicular to the vehicle x axis (longitudinal) and parallel to the road plane.

OVERSTEER
A condition in which the vehicle's yaw rate is greater than the yaw rate that would occur at the vehicle's speed as result of the Ackerman Steer Angle.

COMMON SPACE
An area on which more than one telltale, indicator, identifier, or other message may be displayed, but not simultaneously.

SIDESLIP OR SIDE SLIP ANGLE
The arctangent of the lateral velocity of the center of gravity of the vehicle divided by the longitudinal velocity of the center of gravity.

UNDERSTEER
A condition in which the vehicle's yaw rate is less than the yaw rate that would occur at the vehicle's speed as a result of the Ackerman Steer Angle.

UVW
The Unloaded Vehicle Weight (UVW) is the weight of a vehicle with maximum capacity of all fluids necessary for vehicle operation, but without cargo, occupants, or accessories that are ordinarily removed from the vehicle when they are not in use.

VEHICLE PLACARD AND OPTIONAL TIRE INFLATION PRESSURE LABEL
The sources of cold tire inflation pressure recommended by the vehicle manufacturer and provided in the location and format per Federal motor vehicle safety standard (FMVSS) No. 110.

YAW RATE
The rate of change of the vehicle's heading angle measured in degree/second of rotation about a vertical axis through the vehicle's center of gravity.

12. TEST VEHICLE INSPECTION AND TEST PREPARATION (Data Sheet 1)

A. Inspect test vehicle. Document required test vehicle information.

B. Review all test preparation, safety standard performance, and test instrumentation requirements relating to this compliance test. Personnel supervising and/or performing the compliance test shall be thoroughly familiar with all of the requirements.

C. Review all applicable contents of the vehicle Owner's Manual or equivalent documentation.

D. Verify COTR approval of contractor's detailed in-house test procedure.

E. Verify the calibration status of test equipment.

F. Document vehicle installed tire size, brand and model. All tires must be new. The vehicle must be tested with the tires installed on the vehicle at the time of initial vehicle sale. From the vehicle's Placard or optional Tire Inflation Pressure Label, identify the vehicle's designated tire size(s). Notify COTR if any tire installed on the vehicle is different from the manufacturer's designated tire size obtained from the Vehicle Placard or optional Tire Inflation Pressure Label, and request further guidance before proceeding. Tire changes should not be required; however, if a tire change is necessary no tire mounting lubricant should be used when the tires are mounted to the rims.

G. Identify safety systems installed on vehicle that are intended to improve vehicle stability.

H. Verify outriggers are available for testing. Outriggers must be used for testing trucks, multipurpose passenger vehicles, and buses. Passenger cars will not be tested with outriggers. Vehicles with a baseline weight under 2,722 kg (6,000 lbs) must be equipped with "standard" outriggers and vehicles with a baseline weight equal to or greater than 2,722 kg (6,000 lbs) must be equipped with "heavy" outriggers.

I. Prepare to document every sine with dwell maneuver test executed with a video camera. Sine with dwell maneuvers should be videotaped from a viewpoint that facilitates observation of the inboard side of the vehicle so as to best record instances of wheel lift, if it occurs. During each maneuver the zoom of the camera should be adjusted such that the vehicle fills the view frame to the greatest extent possible.

J. All tests must be performed with automatic transmissions in "Drive." If the test vehicle is equipped with a manual transmission, the highest gear capable of sustaining the desired test speeds shall be used. Manual transmission clutches are to remain engaged during all maneuvers.

K. Data collection is initiated in one of two manners: (1) manually by the test driver immediately before the start of the maneuver, or (2) automatically by using the output signal from the vehicle speed sensor and a closed feedback loop programmed into the steering machine.

L. Brake pedal force is measured with a load cell transducer attached to the face of the brake pedal. While brake pedal force is not explicitly required for determining vehicle compliance, the load cell gives the test laboratory a way of confirming the driver has not unintentionally applied the brakes during execution of the maneuvers. If the driver applies force to the brake pedal before completion of a maneuver, that test is not valid, and should not be considered in further analyses. Monitoring the state of a brake light or brake light switch as a surrogate for brake pedal force is not recommended. For some vehicles, the brake lights are illuminated during ESC intervention, regardless of whether the driver has applied force to the brake pedal. This may cause an otherwise valid test to be incorrectly deemed unacceptable.

M. Calibration data shall be collected prior to each maneuver test series to assist in resolving uncertain test data. The following data should be recorded at the beginning of each test day for each test vehicle. The distance measured by the speed sensor along a straight line between the end points of a surveyed linear roadway standard of 1000 feet or more (observed and recorded manually from the speed sensor display). Five to fifteen seconds of data from all instrument channels as the configured and prepared test vehicle is driven in a straight line on a level, uniform, solid-paved road surface with a vehicle speed of 60 mph.

13. COMPLIANCE TEST EXECUTION

Personnel supervising and/or performing the compliance test program shall be thoroughly familiar with the requirements, test conditions, and equipment for the test to be conducted. Testing will be accomplished as indicated below. Test personnel shall make note of all discrepancies and deviations from the applicable FMVSS and this Laboratory Test Procedure.

13.1 ESC SYSTEM TECHNICAL DOCUMENTATION (Data Sheet 2)

Using information provide by the COTR from the vehicle manufacturer and the owner's manual, verify that the vehicle is equipped with an ESC system that meets the definition of "ESC SYSTEM" by providing the following:

A. List and describe each of the components of the vehicle's ESC system that are used to determine its yaw rate, estimated side slip or the side slip derivative, driver steering inputs, and any other inputs to the ECS system computer, and to generate brake torques at each wheel and other countermeasures (i.e., modifying engine torque) to maintain vehicle stability under conditions B. and C. below. Indicate the location of these components on a vehicle diagram and show how they are connected on a system diagram.

B. Describe and provide a logic diagram to illustrate how the vehicle's ESC system mitigates two oversteer conditions, one more severe than the other. Include the pertinent inputs to the ESC system computer, a description of how the inputs are used to make calculations and provide data to an algorithm, and the outputs to vehicle components (i.e., brakes, engine, etc.) that mitigate those vehicle oversteer conditions. The description must also identify the vehicle speed range and the driving phases (acceleration, deceleration, coasting, during activation of the ABS or traction control) under which the ESC system can activate.

C. Describe and provide a logic diagram to illustrate how the vehicle's ESC system mitigates two understeer conditions, one more severe than the other. Provide the same information requested in B. above.

13.2 ESC MALFUNCTION AND "ESC OFF" TELLTALES -- LOCATION, LABELING AND BULB CHECK (Data Sheet 3)
Note: [Effective September 1, 2011]

A. Locate the ESC malfunction telltale and verify that it is mounted inside the occupant compartment in front of and in clear view of the driver. Describe the telltale location.

B. Verify that the malfunction telltale symbol or abbreviation is as specified in FMVSS No. 101. Identify if the telltale is located in a common space. Make note of any additional symbols and/or words used.

C. Locate the “ESC OFF” telltale, if provided, and verify that it is mounted inside the occupant compartment in front of and in clear view of the driver. Describe the “ESC OFF” telltale location. Verify that the ESC Off telltale symbol or abbreviation is as specified in FMVSS No. 101. Identify if the telltale is located in a common space. Make note of any additional symbols and/or words used.

D. With the vehicle stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “On” (“Run”) position when the engine is not running, or to a position between ”On” (“Run”) and “Start” if designated by the vehicle manufacturer, and verify that the ESC system performs a check of the malfunction and if provided the “ESC OFF” telltale lamp functions. Document the position(s) of the ignition locking system when the malfunction telltale and the “ESC OFF” telltale (if equipped) illuminate. The telltale(s) should be yellow in color and illuminate for a short period of time and then extinguish. Document the color of the illuminated telltale(s). Measure and record the time the telltale(s) remain illuminated. This check of the telltale(s) lamp function is not required for telltales(s) shown in a common space. If the telltale(s) do not illuminate and are not displayed in a common space, proceed to step E.

E. If the telltale(s) does (do) not illuminate in step D, a starter interlock may be engaged. The telltale(s) need not activate as a check of lamp function when a starter interlock is in operation. Review the vehicle Owner’s Manual to determine if the vehicle is equipped with any starter interlocks (most common interlock designs are between the ignition locking system/vehicle starter and the brake pedal and/or transmission). Disengage the interlock and repeat step D above. Describe any interlock features that affect the check of telltale lamp function(s).

13.3 “ESC OFF” CONTROL – IF APPLICABLE (Data Sheet 3)

Note: [Effective September 1, 2011]

A. Determine if vehicle has a control whose only purpose is to place the ESC system in a mode in which it will no longer satisfy the performance requirements set forth in FMVSS No. 126

B. Verify the control is identified by the ESC system off symbol or abbreviation shown in Table 1 of FMVSS No. 101.

C. For vehicles equipped with a dedicated “ESC OFF” control, with the vehicle stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “On” (“Run”) position. Activate the “ESC OFF” control and verify that the “ESC OFF” telltale is illuminated and remains illuminated.

D. Turn the ignition locking system to the “Lock” or “Off” position. Again activate the ignition locking system to the “On” (“Run”) position and verify that the “ESC OFF” telltale extinguishes indicating that the ESC system has been reactivated.

13.4 OTHER SYSTEM CONTROLS – IF APPLICABLE (Data Sheet 3)

A. Determine if vehicle is equipped with controls for other systems that have an ancillary effect on ESC system operation. Review owners manual and other system documentation provided by vehicle manufacturer.

B. With the vehicle stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “On” (“Run”) position. Activate ancillary system control and verify that the “ESC Off” telltale is illuminated and remains illuminated.

C. Turn the ignition locking system to the “Lock” or “Off” position. Again activate the ignition locking system to the “On” (“Run”) position and verify that the “ESC Off” telltale extinguishes indicating that the ESC system has been reactivated.

D. For a mechanical control system (i.e. low speed off-road axle/transfer case) that cannot reset ESC electronically, and with the vehicle stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “On” (“Run”) position. Activate mechanical control system and verify that the “ESC Off” telltale is illuminated and remains illuminated.

E. De-activate mechanical control system, and verify that the “ESC Off” telltale extinguishes indicating that the ESC system has been reactivated.

13.5 VEHICLE AND TEST TRACK DATA (Data Sheet 4)

A. Document the test track peak friction coefficient (PFC). The road test surface must produce a PFC of 0.9 when measured using an American Society for Testing and Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E 1337-90, at a speed of 64.4 km/h (40 mph), without water delivery.

B. Verify that the test track being used is dry and uniform with a solid-paved surface. Surfaces with irregularities and undulations, such as dips and large cracks, are unsuitable. The test surface must have a consistent slope between level and 1%.

C. Fill the fuel tank and other reservoirs of fluids necessary for operation of the vehicle prior to executing this test.

D. Inflate vehicle tires to the recommended cold inflation pressure as specified on the vehicle placard or optional tire inflation pressure label.

E. Weigh unloaded vehicle. Document unloaded vehicle weight (UVW).

F. For vehicles other than passenger cars, install outriggers on vehicle. To determine outrigger size required for test vehicle, add weight of test driver (73 kg (160lb)) to the UVW determined in E to calculate vehicle baseline weight. The vehicle baseline weight should be used to determine the size of outriggers to use as discussed in paragraph 9I. With outriggers installed, again determine and document vehicle weight.

G. Install and calibrate all test instrumentation following the check-off list provided as part of data sheet 4.

H. Load the vehicle with test driver and ballast so the total interior load is 168 kg (370 lb) comprising the test driver, test equipment and ballast as required to account for the differences in the weight of test drivers and test equipment. Where required, ballast shall be placed on the floor behind the passenger front seat or if necessary in the front passenger foot well area.

I. Weigh vehicle and adjust ballast as required to achieve total vehicle interior load of 168 kg (370 lb). Secure ballast in a way that prevents it from becoming dislodged during test conduct. Document loaded vehicle weight.

J. Determine the loaded vehicle's longitudinal and lateral center of gravity (CG) coordinates. Document CG coordinates for the vehicle's loaded configuration.

K. Readjust location of ultrasonic distance measuring sensors to align with the vehicle's measured longitudinal center of gravity position.

L. Measure coordinates of installed inertial sensing system relative to the vehicles CG location.

13.6 BRAKE CONDITIONING (Data Sheet 5)

A. Verify tires are properly inflated to the vehicle manufacturer's recommended cold inflation pressures.

B. Measure and record ambient temperature and wind speed. Verify wind speed and ambient temperature are within required test conditions.

C. Energize the data acquisition system. Set data acquisition system so vehicle longitudinal acceleration can be observed on the system's display by the test driver.

D. Execute ten stops from a speed of 56 km/h (35 mph), with an average deceleration of approximately 0.5g. During each brake application the test driver will visually monitor the actual measured longitudinal acceleration on the data acquisition system display and attempt to maintain the target of 0.5g deceleration over the entire brake event.

E. Immediately following the series of 56 km/h (35 mph) stops, execute 3 stops from a speed of 72 km/h (45 mph). During the 72 km/h (45 mph) stops, brake pedal force should be great enough to activate the vehicle's antilock brake system (ABS) for the majority of each braking event. During each stop the test driver should be able to identify activation of the ABS (by feel or sound). If during a brake application the ABS does not activate the brake application should be repeated with increased brake pedal force. If the driver experiences any wheel lock-up he/she should confer with the COTR before proceeding.

F. Following completion of the final 72 km/h (45 mph) stop, the vehicle shall be driven at a speed of 72 km/h (45 mph) for at least five minutes to cool the brakes.

13.7 TIRE CONDITIONING (Data Sheet 5)

Tire conditioning is required to wear away mold sheen and achieve tire operating temperatures immediately before executing the test maneuvers of sections 13.8 and 13.9

A. Verify tires are properly inflated to the vehicle manufacturer's recommended cold inflation pressures.

B. Measure and record ambient temperature and wind speed. Verify wind speed and ambient temperature are within required test conditions.

C. Energize the data acquisition system. Set data acquisition system so vehicle measured lateral acceleration can be observed on the system's display by the test driver.

D. Drive the vehicle around a 30 meter (100 feet) diameter circle at a speed that produces a lateral acceleration of approximately 0.5 to 0.6 g for three clockwise laps followed by three counterclockwise laps. During each lap the test driver will visually monitor the actual measured lateral acceleration on the data acquisition system display and attempt to maintain the target of 0.5 to 0.6 g lateral acceleration over the entire 30 meter (100 feet) diameter circle. Make note of the targeted vehicle speed.

E. Energize the automatic steering controller. Program the controller with a 1Hz, 3 cycle sinusoidal steering pattern and a steering wheel angle that corresponds to a peak lateral acceleration of 0.5-0.6 g at a constant vehicle speed of 56 km/h (35 mph). To determine the appropriate steering wheel angle required several preliminary steering maneuvers must be conducted. Using a target steering wheel angle of 30 degrees execute the sinusoidal steering maneuver at 56 km/h (35 mph) while observing the lateral acceleration. Adjust the target steering wheel angle as necessary and repeat the steering maneuver until a peak lateral acceleration of 0.5-0.6 g is obtained at the programmed steering wheel angle. Document the steering wheel angle required that corresponds to a peak lateral acceleration of 0.5-0.6 g.

F. Program the steering controller with a 1HZ, 10 cycle sinusoidal steering pattern using the steering wheel angle for a peak lateral acceleration of 0.5-0.6 g determined in step E. Execute three steering maneuvers while maintaining a vehicle speed of 56 km/h (35 mph).

G. Modify the programmed steering controller 1HZ, 10 cycle sinusoidal steering pattern. The steering wheel angle for the first nine cycles should be the same as used in step F. The steering wheel angle for the tenth cycle should be twice that of the other cycles. Execute one steering maneuver while maintaining a vehicle speed of 56 km/h (35 mph).

NOTE: The maximum time permitted between all laps and passes executed in section 13.7 is five minutes.

13.8 SLOWLY INCREASING STEER (SIS) MANEUVER (Data Sheet 6)

The SIS maneuver is used to characterize the lateral dynamics of each vehicle. The maneuver is used to provide the data necessary for determining the steering wheel angle capable of producing a lateral acceleration of 0.3 g. This steering wheel angle is then used to determine the magnitude of steering required during the sine with dwell maneuver executed in section 13.9.

A. Verify tires are properly inflated to the vehicle manufacturer's recommended cold inflation pressures.

B. Measure and record ambient temperature and wind speed. Verify wind speed and ambient temperature are within required test conditions.

C. Energize the data acquisition system and the automatic steering controller. Program the steering controller so at time zero the steering wheel angle is linearly increased from zero to 30 degrees at a rate of 13.5 degrees per second.

D. Execute a preliminary left steer maneuver and measure the lateral acceleration at the 30 degree steering wheel angle. To begin, the vehicle is driven in a straight line at 80 $\pm$ 2 km/h (50 $\pm$ 1 mph). While maintaining a vehicle speed of 80 $\pm$ 2 km/h (50 $\pm$ 1 mph) using smooth throttle modulation, the driver should activate the steering controller. The driver must attempt to maintain a vehicle speed of 80 $\pm$ 2 km/h (50 $\pm$ 1 mph) during and briefly after the steering maneuver is executed by the steering controller. The 30 degree steering wheel angle must be held constant for two seconds after which the maneuver is concluded. The steering wheel is then returned to zero degrees. Document the measured lateral acceleration at the 30 degree steering wheel angle.

E. Assuming a linear relationship exists between the steering wheel angle and lateral acceleration, calculate the steering angle required to achieve a 0.55 g lateral acceleration using equation 1. See note below.

Equation 1:

$$\frac{30\,\text{degrees}}{a_{\text{y,30 degrees}}} = \frac{\delta_{SIS}}{0.55\,\text{g}}$$

where,

$a_{y,30\ degrees}$ is the raw lateral acceleration produced with a constant SWA of 30 degrees during a test performed at 50 mph

δ_{SIS} is the steering wheel angle, if the relationship of SWA and lateral acceleration was linear, would produce a lateral acceleration of 0.55 g during a test performed at 50 mph

NOTE: The 30 degree steering wheel angle was selected by NHTSA because it is believed to be capable of producing a steady state lateral acceleration within the linear range for any light vehicle. The measured lateral acceleration ($a_{y,30\ degrees}$) is "raw" data, not corrected for the effects of roll, pitch, and yaw. NHTSA acknowledges the relationship of the steering wheel angle and *corrected* lateral acceleration data is often not linear at 0.55 g. However, previously collected data indicates the magnitude of raw 0.55 g acceleration data is typically reduced by approximately 9.6 percent to 0.50 g, when corrected for roll, pitch, and yaw, just outside of the linear range for most vehicles. Removing the effect of accelerometer offset (error due to the accelerometer not being positioned at the vehicle's actual center of gravity) typically reduces the magnitude of these data by an additional 0.07 percent. The importance of the above equation is that it simply provides test laboratories with a direct, "in-the-field" way of determining an appropriate steering input for which to proceed with SIS test for a given vehicle.

F. Re-program the steering controller so at time zero the steering wheel angle is linearly increased from zero degrees to δ_{SIS} at a rate of 13.5 degrees per second.

G. Execute six SIS maneuvers and record the steering wheel angle and lateral acceleration data from 0 to 0.55g. To begin, the vehicle is driven in a straight line at 80 $\pm$ 2 km/h (50 $\pm$ 1 mph). While maintaining a vehicle speed of 80 $\pm$ 2 km/h (50 $\pm$ 1 mph) using smooth throttle modulation, the driver should activate the steering controller. The driver must attempt to maintain a vehicle speed of 80 $\pm$ 2 km/h (50 $\pm$ 1 mph) during and briefly after the steering maneuver is executed by the steering controller. The steering wheel angle must be held constant at δ_{SIS} for two seconds, after which the maneuver is concluded. The steering wheel is then returned to zero degrees. The maneuver is performed three times to the left (counterclockwise) and three times to the right (clockwise). The maximum time permitted between each test run maneuver is five minutes. Figure 1 presents a description of the SIS steering profile. For each of the six test runs document the time, steering wheel angle and lateral acceleration from 0 to 0.55g.

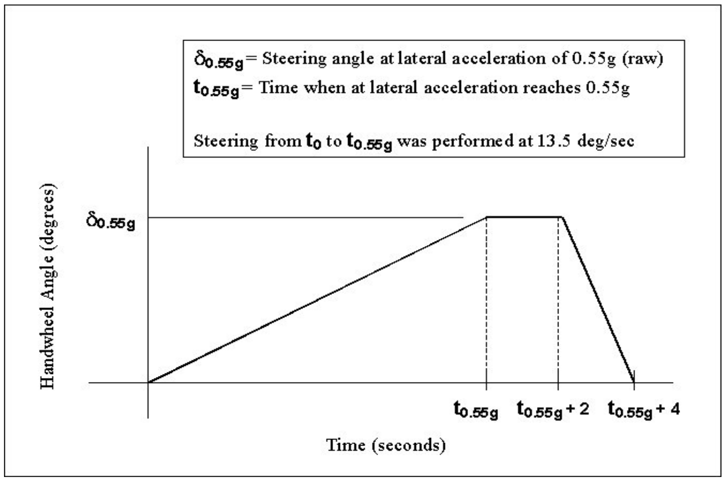

Figure 1. Slowly Increasing Steer steering profile.

H. Obtain raw lateral acceleration data by filtering with a 12-pole phaseless Butterworth filter and a cutoff frequency of 6Hz. The filtered data is then zeroed to remove sensor offset utilizing static pretest data. The lateral acceleration data at the vehicle CG is determined by removing the effects caused by vehicle body roll and by correcting for sensor placement via use of coordinate transformation. For data collection, the lateral accelerometer shall be located as close as possible to the position of the vehicle's longitudinal and lateral CG.

I. Using linear regression techniques, determine the "best-fit" linear line for each of the six completed SIS maneuvers. When lateral acceleration data collected during SIS tests are plotted with respect to time, a first order polynomial (best-fit line) accurately describes the data from 0.1 to 0.375 g. NHTSA defines this as the linear range of the lateral acceleration response. A simple linear regression is used to determine the best-fit line, as shown in Figure 2.

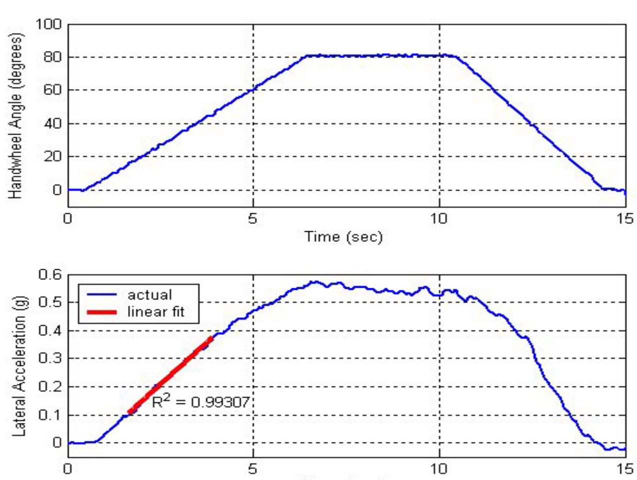

Figure 2. Sample steering wheel angle and lateral acceleration data recorded during a Slowly Increasing Steer test. The linear range used to define the lateral acceleration regression line is highlighted.

J. Using the slope of the best-fit line for each of the six SIS maneuvers, determine the steering wheel angle, to the nearest 0.1 degree, at 0.3 g for each respective maneuver. Using equation 2 calculate the average overall steering wheel angle, rounded to the nearest 0.1 degree, at 0.3 g using the absolute value data from each of the six SIS maneuvers.

Equation 2:

$$\delta_{0.3\text{ g, overall}} = (\left|\delta_{0.3\text{ g, left (1)}}\right| + \left|\delta_{0.3\text{ g, left (2)}}\right| + \left|\delta_{0.3\text{ g, left (3)}}\right| + \delta_{0.3\text{ g, right (1)}} + \delta_{0.3\text{ g, right (2)}} + \delta_{0.3\text{ g, right (3)}}) / 6$$

13.9 VEHICLE LATERAL STABILITY AND RESPONSIVENESS (SINE WITH DWELL MANEUVER) (Data Sheet 7)

The vehicle is subjected to two series of test runs using a steering pattern of a sine wave at 0.7 Hz frequency with a 500ms delay beginning at the second peak amplitude as shown in Figure 3 (the sine with dwell test). One series uses counterclockwise steering for the first half cycle, and the other series uses

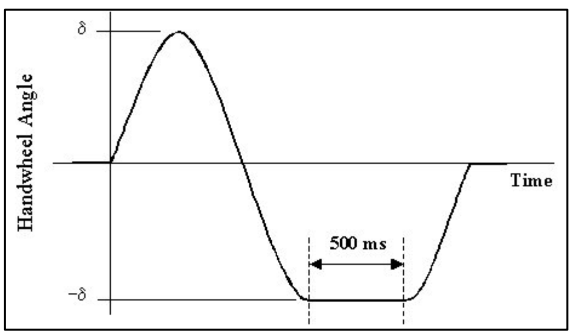

Figure 3. Sine with Dwell

clockwise steering for the first half cycle. The vehicle is provided a cool-down period between each test run of 90 seconds to five minutes, with the vehicle stationary. Ensure the sine with dwell test series begins within two hours after the completion of the SIS tests.

A. Repeat the tire conditioning procedure specified in section 13.7. Tire conditioning must be executed immediately prior to executing the sine with dwell maneuvers.

B. Verify that the ESC system is enabled, by ensuring that the ESC malfunction and “ESC OFF” (if provided) telltales are not illuminated.

C. Verify the data acquisition system is energized and conduct on-track calibration checks for speed, distance and inertial sensing system sensor output. At the completion of the tire conditioning procedure and before the start of a test series, fifteen seconds of data are collected from all instrument channels with the test vehicle at rest, the engine running, the transmission in "Park" (automatic transmission) or in neutral with the parking brake applied (manual transmission), and the front of the test vehicle facing in the direction the vehicle will be tested on the track. The static data files are used in post processing to establish datums for each instrument channel.

D. Energize the programmable steering controller. Program the controller to execute the sine with dwell maneuver using an initial counterclockwise steering direction. The first maneuver should be programmed with a steering wheel angle magnitude equal to 1.5 times $\delta_{0.3\ g,\ overall.}$ as determined in section 13.7.

E. Depress the steering controller's program switch and then accelerate the vehicle to 87 $\pm$ 2 km/h (54$\pm$1 mph). Release the throttle, and when vehicle speed reaches the target speed of 80 $\pm$ 2 km/h (50 $\pm$ 1 mph) the steering controller will execute the programmed sine with dwell maneuver.

F. During the maneuver, test personnel must observe for loss of pavement contact of tires, rim-to-pavement contact and tire debeading. Rim-to-pavement contact will be verified by visual observation and identified by marks left on the pavement. Debeading will be verified by visual observation and a corresponding loss of tire inflation pressure. Loss of pavement contact of tires will be verified by visual observation and documented by video camera. If any of these events are observed or if the test driver experiences a vehicle loss of control or spinout the test should be terminated and the test laboratory must consult with the COTR before proceeding.

G. Safety outrigger height adjustment may be required during a test series. If an outrigger skid pad contacts the road surface during a test run wherein there is no spinout or wheel lift, the outrigger at the effected end of the vehicle is raised 19 mm (0.75 in) and the test run is repeated. If both outriggers make contact with the test surface during at test run wherein there is no spinout or wheel lift, both outriggers are raised 19 mm (0.75 in) and the test run is repeated.

H. Continue to execute the counterclockwise steering maneuvers, each time increasing the steering wheel angle magnitude by multiples of $0.5^*\delta_{0.3\ g,\ overall}$. Maneuver execution should continue until a steering wheel angle magnitude factor of $6.5^*\delta_{0.3\ g,\ overall}$ or 270 degrees is utilized, whichever is greater, provided the calculated magnitude of $6.5*\delta_{0.3\text{ g, overall}}$ is less than or equal to 300 degrees. If $6.5*\delta_{0.3\text{ g, overall}}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of $0.5*\delta_{0.3\text{ g, overall}}$ without exceeding the 270 degree steering wheel angle. If the highest calculated multiple of $0.5*\delta_{0.3\text{ g, overall}}$ falls within the range of 260 - 270 degrees the final maneuver should be conducted at that angle, otherwise, the final maneuver should be conducted at the 270 degree steering wheel angle. If any $0.5*\delta_{0.3\text{ g, overall}}$ increment, up to $6.5*\delta_{0.3\text{ g, overall}}$, is greater than 300 degrees, the steering amplitude of the final run shall be 300 degrees.

I. Repeat paragraphs D. through H. using an initial clockwise steering direction.

13.10 CALCULATIONS OF PERFORMANCE METRICS – POST DATA PROCESSING (Data Sheet 7)

Yaw rate and lateral displacement measurements and calculations must be processed utilizing the following techniques:

A. Filter raw steering wheel angle data with a 12-pole phaseless Butterworth filter and a cutoff frequency of 10 Hz. Zero the filtered data to remove sensor offset utilizing static pretest data.

B. Filter raw yaw, pitch and roll rate data with a 12-pole phaseless Butterworth filter and a cutoff frequency of 6 Hz. Zero the filtered data to remove sensor offset utilizing static pretest data.

C. Filter raw lateral, longitudinal and vertical acceleration data with a 12-pole phaseless Butterworth filter and a cutoff frequency of 6 Hz. Zero the filtered data to remove sensor offset utilizing static pretest data.

D. Filter raw speed data with a 12-pole phaseless Butterworth filter and a cutoff frequency of 2 Hz.

E. Filter left side and right side ride height data with a 12-pole phaseless Butterworth filter and a cutoff frequency of 6 Hz. Zero the filtered data to remove sensor offset utilizing static pretest data.

F. Determine the roll and yaw accelerations by differentiating the filtered and zeroed roll and yaw rate data.

G. Determine the lateral acceleration at the vehicle center of gravity by removing the effects caused by vehicle body roll and by correcting for sensor placement via use of coordinate transformation using the following equations:

1. The multi-axis inertial sensing system is used to measure linear accelerations and roll, pitch, and yaw angular rates. The position of the multi-axis inertial sensing system must be accurately measured relative to the C.G. of the vehicle in its loaded configuration. These data are required to translate the motion of the vehicle at the measured location to that which occurred at the actual C.G to remove roll, pitch, and yaw effects. The following equations are used to correct the accelerometer data in post-processing. They were derived from equations of general relative acceleration for a translating reference frame and use the SAE Convention for Vehicle Dynamics Coordinate Systems. The coordinate transformations are:

Equation 4: $x''_{corrected} = x''_{accel} - (\Theta'^2 + \Psi'^2)x_{disp} + (\Theta'\Phi' - \Psi'')y_{disp} + (\Psi'\Phi' + \Theta'')z_{disp}$

Equation 5: $y''_{corrected} = y''_{accel} + (\Theta'\Phi' + \Psi'')x_{disp} - (\Phi'^2 + \Psi'^2)y_{disp} + (\Psi'\Theta' - \Phi'')z_{disp}$

Equation 6: $z''_{corrected} = z''_{accel} + (\Psi'\Phi' - \Theta'')x_{disp} + (\Psi'\Theta' + \Phi'')y_{disp} - (\Phi'^2 + \Theta'^2)z_{disp}$

Where;

$x''_{corrected}$, $y''_{corrected}$, and $z''_{corrected}$ = longitudinal, lateral, and vertical accelerations, respectively, at the vehicle's center of gravity

x''_{accel}, y''_{accel}, and z''_{accel} = longitudinal, lateral, and vertical accelerations, respectively, at the accelerometer location

x_{disp}, y_{disp}, and z_{disp} = longitudinal, lateral, and vertical displacements, respectively, of the center of gravity with respect to the accelerometer location

Φ' and Φ'' = roll rate and roll acceleration, respectively

Θ' and Θ'' = pitch rate and pitch acceleration, respectively

Ψ' and Ψ'' = yaw rate and yaw acceleration, respectively

2. NHTSA does not use inertially stabilized accelerometers for this test

procedure. Therefore, lateral acceleration must be corrected for vehicle roll angle during data post processing. The ultrasonic distance measurement sensors are used to collect left and right side vertical displacements for the purpose of calculating vehicle roll angle. One ultrasonic ranging module is mounted on each side of a vehicle, and is positioned at the longitudinal center of gravity. With these data, roll angle is calculated during post-processing using trigonometry.

Equation 7: $$a_{yc} = a_{ym}\cos\Phi - a_{zm}\sin\Phi$$

Where;

a_{yc} is the corrected lateral acceleration (i.e., the vehicle's lateral acceleration in a plane horizontal to the test surface)

a_{ym} is the measured lateral acceleration in the vehicle reference frame

a_{zm} is the measured vertical acceleration in the vehicle reference frame

Φ is the vehicle's roll angle

Note: The z-axis sign convention is positive in the downward direction for both the vehicle and test surface reference frames.

H. Determine steering wheel velocity by differentiating the filtered steering wheel angle data. Filter the steering wheel velocity data using a moving 0.1 second running average filter.

I. Zero lateral acceleration, yaw rate and steering wheel angle data channels utilizing a defined "zeroing range." The methods used to establish the zeroing range are as follows:

1. Using the steering wheel velocity data calculated using the methods described in E., the first instant steering wheel rate exceeds 75 deg/sec is identified. From this point, steering wheel rate must remain greater than 75 deg/sec for at least 200 ms. If the second condition is not met, the next instant steering wheel rate exceeds 75 deg/sec is identified and the 200 ms validity check applied. This iterative process continues until both conditions are ultimately satisfied.

2. The "zeroing range" is identified as the 1.0 seconds time period prior to

the instant the steering wheel rate exceeds 75 deg/sec (i.e., the instant the steering wheel velocity exceeds 75 deg/sec defines the end of the "zeroing range").

J. Determine the "Beginning of Steer" (BOS) which is defined as the first instance filtered and zeroed steering wheel angle data reaches -5 degrees (when the initial steering input is counterclockwise) or +5 degrees (when the initial steering input is clockwise) after time defining the end of the "zeroing range." The value for time at the BOS is interpolated.

K. Determine the "Completion of Steer" (COS) which is defined as the time the steering wheel angle returns to zero at the completion of the sine with dwell steering maneuver. The value for time at the zero degree steering wheel angle is interpolated.

L. Determine the second peak yaw rate ($\dot{\psi}_{Peak}$) which is defined as the first local yaw rate peak produced by the reversal of the steering wheel. Refer to figure 4.

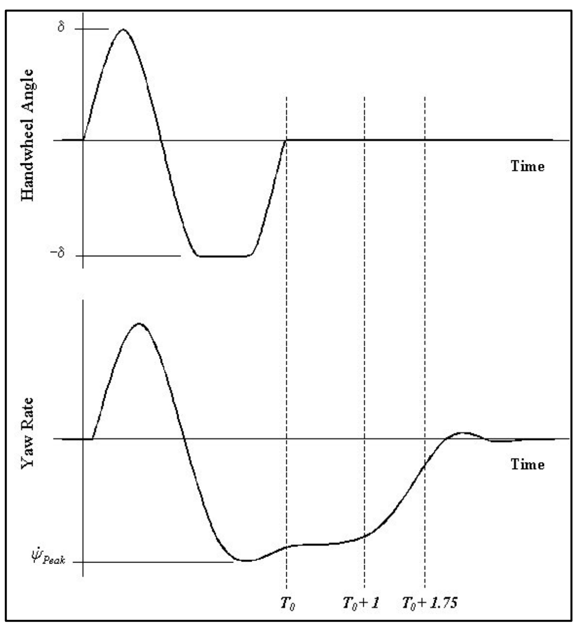

Figure 4. Steering wheel position and yaw velocity information used to assess lateral stability.

Note: In figure 4, $\dot{\psi}_{Peak}$ is the <u>first</u> local peak yaw rate resulting from the sine with dwell steering reversal. In some situations, the yaw rate produced by the steering reversal may reach a peak ($\dot{\psi}_{Peak}$), decay slightly, then increase to a level beyond a $\dot{\psi}_{Peak}$. Even though the overall peak magnitude of the yaw rate response may exceed $\dot{\psi}_{Peak}$, only $\dot{\psi}_{Peak}$ shall be used in the calculation process.

M. Determine the yaw rates at 1.000 and 1.750 seconds after COS are determined by interpolation for each counterclockwise and clockwise steering maneuvers.

N. For each of the steering maneuvers calculate the yaw rate ratio (YYR) at 1.00 second. The yaw rate measured one second after COS must not exceed 35 percent of the second peak value of the yaw velocity recorded ($\dot{\psi}_{Peak}$) during the same test run. The YYR is expressed as a percentage as shown in equation 3 below.

Equation 3:

$$\mathrm{YYR} = 100 * \left(\frac{\dot{\psi}(\text{at time } t)}{\dot{\psi}_{Peak}} \right)$$

O. Using equation 3 above, calculate yaw rate ratio (YYR) at 1.75 seconds for each of the steering maneuvers. The yaw rate measured 1.75 seconds after COS must not exceed 20 percent of the second peak value of the yaw velocity recorded ($\dot{\psi}_{Peak}$) during the same test run.

P. For each of the steering maneuvers executed in sections E., H., and I., with a steering wheel angle of $5^*\delta_{0.3\text{ g, overall}}$ or greater, determine lateral velocity by integrating corrected, filtered and zeroed lateral acceleration data. Zero lateral velocity at BOS event.

Q. Determine lateral displacement by integrating zeroed lateral velocity. Zero lateral displacement at BOS event.

R. Determine lateral displacement at 1.07 seconds from BOS event using interpolation. The lateral displacement of the vehicle center of gravity with respect to its initial straight path must be at least 1.83 (6 feet) for vehicles with a GVWR of 3,500 kg (7,716 lb) or less, and 1.52 m (5 feet) for vehicles with GVWR greater than 3,500 kg (7,716 lb) when computed 1.07 seconds after the BOS.

13.11 ESC MALFUNCTION WARNING (Data Sheet 8)

A. With the vehicle stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “On” (“Run”) position when the engine is not running, or to a position between “On” (“Run”) and “Start” if designated by the vehicle manufacturer, and verify bulb check function of the malfunction telltale (until September 1, 2011, the ABS telltale may be used). If vehicle is equipped with a telltale that is shown in a common space, it is not required to illuminate as a check of lamp function upon cycling the ignition locking system (refer to section 13.3D. Deactivate the ignition locking system to the “Lock” of “Off” position.

B. As directed by the COTR, simulate one or more of the following ESC malfunctions by disconnecting the power source to any ESC component, or disconnecting any electrical connection between ESC components (with the vehicle power off). When simulating an ESC malfunction, the electrical connections for the telltale lamp(s) are not to be disconnected. Also, until September 1, 2011, a disconnection of the “ESC OFF” control need not illuminate the ESC malfunction telltale.

C. With the vehicle initially stationary and the ignition locking system in the “Lock” or “Off” position, activate the ignition locking system to the “Start” position and start the engine. Place the vehicle in a forward gear and obtain a vehicle speed of 48 $\pm$ 8 km/h (30 $\pm$ 5 mph). Drive the vehicle for at least two minutes including at least one left and one right turning maneuver. Verify that within two minutes of obtaining this vehicle speed the ESC malfunction indicator illuminates.

D. Stop the vehicle, deactivate the ignition locking system to the “Off” or “Lock” position. After a five-minute period, activate the vehicle’s ignition locking system to the “Start” position and start the engine. Verify that the ESC malfunction indicator again illuminates to signal a malfunction and remains illuminated as long as the engine is running or until the fault is corrected.

E. Deactivate the ignition locking system to the “Off” or “Lock” position. Restore the ESC system to normal operation, activate the ignition system to the “Start” position and start the engine. Verify that the telltale has extinguished.

F. Repeat steps A.-E. using another method of malfunction simulation as directed by the COTR.

14. POST TEST REQUIREMENTS

A. Verify all data sheets have been completed and all photographs have been taken.

B. Remove all instrumentation from vehicle. Return vehicle to its pretest condition.

C. Complete the Vehicle Condition Report form including a word description of the vehicle's post test condition.

D. Copy applicable pages of the Owner's Manual for attachment to the final test report.

15. REPORTS

15.1. MONTHLY STATUS REPORTS

The contractor shall submit a monthly Test Status Report and a Vehicle Status Report to the COTR. The Vehicle Status report shall be submitted until all vehicles are disposed of. Samples of the required reports are found in the report forms section.

15.2. APPARENT NONCOMPLIANCE

Any indication of a test failure shall be communicated by telephone to the COTR within 24 hours with written notification mailed within 48 hours (Saturdays and Sundays excluded). A Notice of Test Failure (see report forms section) with a copy of the particular compliance test data sheet(s) and preliminary data plot(s) shall be included. In the event of a test failure, a post test calibration check of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COTR's discretion and shall be performed without additional costs to the OVSC.

15.3 FINAL TEST REPORTS

15.3.1 COPIES

In the case of an apparent test failure, seven paper copies and electronic copies in both Word and pdf formats of the Final Test Report shall be submitted to the COTR for acceptance within three weeks of test completion. The Final Test Report format to be used by all contractors can be found in the "Report Section". Where there has been no indication of an apparent noncompliance, three paper copies and electronic copies in both Word and pdf formats of each Final Test

Report shall be submitted to the COTR for acceptance within three weeks of test completion. No payment of contractor's invoices for conducting compliance tests will be made prior to the Final Test Report acceptance by the COTR. Contractors are requested to NOT submit invoices before the COTR is provided with copies of the Final Test Report.

Contractors are required to submit the first Final Test Report in draft form within one week after the compliance test is conducted. The contractor and the COTR will then be able to discuss the details of both test conduct and report content early in the compliance test program.

Contractors are required to PROOF READ all Final Test Reports before submittal to the COTR. The OVSC will not act as a report quality control office for contractors. Reports containing a significant number of errors will be returned to the contractor for correction, and a "hold" will be placed on invoice payment for the particular test.

15.3.2 REQUIREMENTS

The Final Test Report and associated documentation (including photographs) are relied upon as the chronicle of the compliance test. The Final Test Report will be released to the public domain after review and acceptance by the COTR. For these reasons, each final report must be a complete document capable of standing by itself. The contractor should use DETAILED descriptions of all compliance test events. Any events that are not directly associated with the standard but are of technical interest should also be included. The contractor should include as much DETAIL as possible in the report. Instructions for the preparation of the first three pages of the final test report are provided for standardization.

15.3.3 FIRST THREE PAGES

A. FRONT COVER

A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

(1) Final Report Number such as 126-ABC-0X-001, where –

126 is the FMVSS tested
ABC are the initials for the laboratory
0X is the Fiscal Year of the test program
001 is the Group Number (001 for the 1st test,

002 for the 2nd test, etc.)

(2) Final Report Title And Subtitle such as

SAFETY COMPLIANCE TESTING FOR FMVSS 126
Electronic Stability Control Systems
* * * * * * * * * * * * * * * *
ABC Motor Company
200X Saferider 4-door sedan
NHTSA No. CX0401

(3) Contractor's Name and Address such as

COMPLIANCE TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090-1234

NOTE: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (3) AND (4)

(4) Date of Final Report completion

(5) The words "FINAL REPORT"

(6) The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
400 Seventh Street, SW
Room 6111 (NVS-220)
Washington, DC 20590

B. FIRST PAGE AFTER FRONT COVER

A disclaimer statement and an acceptance signature block for the COTR shall be provided as follows:

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Prepared By:

Approved By:

Approval Date:

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By:

Acceptance Date:

15. REPORTS....Continued

C. SECOND PAGE AFTER FRONT COVER

A completed Technical Report Documentation Page (Form DOT F1700.7) shall be completed for those items that are applicable with the other spaces left blank. Sample data for the applicable block numbers of the title page follows.

Block 1 — REPORT NUMBER

126-ABC-0X-001

Block 2 — GOVERNMENT ACCESSION NUMBER

Leave blank

Block 3 — RECIPIENT'S CATALOG NUMBER

Leave blank

Block 4 — TITLE AND SUBTITLE

Final Report of FMVSS 110 Compliance Testing of 200X Saferider 4-door sedan, NHTSA No. CX0401

Block 5 — REPORT DATE

March 1, 200X

Block 6 — PERFORMING ORGANIZATION CODE

ABC

Block 7 — AUTHOR(S)

John Smith, Project Manager
Bill Doe, Project Engineer

Block 8 — PERFORMING ORGANIZATION REPORT NUMBER

ABC-DOT-XXX-001

15. REPORTS....Continued

Block 9 — PERFORMING ORGANIZATION NAME AND ADDRESS

ABC Laboratories
405 Main Street
Detroit, MI 48070-1234

Block 10 — WORK UNIT NUMBER

Leave blank

Block 11 — CONTRACT OR GRANT NUMBER

DTNH22-0X-D-12345

Block 12 — SPONSORING AGENCY NAME AND ADDRESS

United States Department of Transportation
National Highway Traffic Safety Administration
Office of Vehicle Safety Compliance
400 Seventh Street, SW, Room 6111
Washington, DC 20590

Block 13 — TYPE OF REPORT AND PERIOD COVERED

Final Test Report
Feb. 15 to Mar. 15, 200X

Block 14 — SPONSORING AGENCY CODE

NVS-220

Block 15 — SUPPLEMENTARY NOTES

Leave blank

15. REPORTS....Continued

Block 16 — ABSTRACT

Compliance tests were conducted on the subject 200X Saferider 4-door sedan in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-126-0X for the determination of FMVSS 126 compliance. Test failures identified were as follows:

None

NOTE: Above wording must be shown with appropriate changes made for a particular compliance test. Any questions should be resolved with the COTR.

Block 17 — KEY WORDS

Compliance Testing
Safety Engineering
FMVSS 126

Block 18 — DISTRIBUTION STATEMENT

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Unclassified

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Add appropriate number

15. REPORTS....Continued

Block 22 — PRICE

Leave blank

15.3.4 TABLE OF CONTENTS

Final test report Table of Contents shall include the following:

Section 1 — Purpose of Compliance Test

Section 2 — Test Procedure and Discussion of Results

Section 3 — Test Data

Section 4 — Test Equipment List and Calibration Information

Section 5 — Photographs

Section 6 — Other Documentation

Section 7 — Notice of Test Failure (if applicable)

16. DATA SHEETS

DATA SUMMARY SHEET (1 of 2)

VEHICLE MAKE/MODEL/BODY STYLE:______________________________________

VEHICLE NHTSA NO.: ____________ VIN: ___________________________________

VEHICLE TYPE: _______________________ DATE OF MANUFACTURE: __________

LABORATORY:____

REQUIREMENTS	PASS/FAIL
ESC Equipment and Operational Characteristics (Data Sheet 2)	
The vehicle is be equipped with an ESC system that meets the equipment and operational characteristics requirements. (S126, S5.1, S5.6)	__________
ESC Malfunction Telltale – Location, Labeling and Bulb Check* (Data Sheet 3) *Requirements effective on and after September 1, 2011	
Telltale meets the requirements for mounting, symbol or text, color and check of lamp function. (S126, S5.3.1, S5.3.2, S5.3.4 and S5.3.5, S5.3.6)	__________
"ESC Off" and other System Controls and Telltale* (Data Sheet 3)	
If provided, telltale meets the requirements for mounting, symbol or abbreviation, color and check of lamp function. (S126, S5.5.2, S5.5.3, S5.5.6, S5.5.7, and S5.5.8)	__________
If provided, dedicated off control meets the label requirements (S126, S5.4.2)	__________
If provided, off control and other system controls meets the operational requirements (S126, S5.4, S5.4.1, S5.4.3, S5.4.5, S5.4.8, S5.5.4, and S5.5.9)	__________
Vehicle Lateral Stability (Data Sheet 7)	
Yaw Rate Ratio at 1 second after COS is less than 35% of peak value. (S126, S5.2.1)	__________
Yaw Rate Ratio at 1.75 seconds after COS is less than 20% of peak value. (S126, S5.2.2)	__________

16. DATA SHEETS….continued

DATA SUMMARY SHEET (2 of 2)

REQUIREMENTS	PASS/FAIL
Vehicle Responsiveness (Data Sheet 7)	
Lateral displacement at 1.07 seconds after BOS is at least 1.83 m (6 feet) for vehicles with a GVWR of 3,500kg (7,716 lb) or less, and 1.52 m (5 feet) for vehicles with a GVWR greater than 3,500 kg (7,716 lb). (S126 S5.2.3)	___________
ESC Malfunction Warning (Data Sheet 8)	
Warning is provided to driver after malfunction occurrence. (S126. S5.3.3, S5.3.9)	___________
Malfunction telltale stayed illuminated as long as malfunction existed and must extinguished after malfunction was corrected. (S126, S5.3.3, S5.3.7)	___________

16. DATA SHEETS....continued

DATA SHEET 1
TEST VEHICLE INSPECTION AND TEST PREPARATION

VEHICLE MAKE/MODEL/BODY STYLE:_______________________________________

NHTSA No.:________________________ TEST DATE:________________________

VIN:_______________________________ MANUFACTURE DATE:_____________

GVWR:___________KG FRONT GAWR:__________ KG REAR GAWR________KG

SEATING POSITIONS: FRONT________ MID ________ REAR ____________

ODOMETER READING AT START OF TEST: ________________ Miles (Kilometers)

DESIGNATED TIRE SIZE(S) FROM VEHICLE LABELING:
Front Axle____________________ Rear Axle ____________________

INSTALLED TIRE SIZE(S) ON VEHICLE:

From Tire Sidewall	Front Axle	Rear Axle
Manufacturer and Model	____________________	_______________________
Tire Size Designation	____________________	_______________________

Are installed tire sizes same as labeled tire sizes? ______ Yes ______ No
If no, contact COTR for further guidance.

DRIVETRAIN CONFIGURATION:
______ Front Wheel Drive (FWD) ______Rear Wheel Drive (RWD)
______ Four Wheel Drive (4WD) ______ All Wheel Drive (AWD)

VEHICLE STABILITY SYSTEMS (Check applicable technologies):
______ESC ______ Traction Control _____ Roll Stability Control
______Active Suspension ______Electronic Throttle Control _____ Active Steering
______ABS
List other systems; ____

REMARKS:

RECORDED BY: _______________________________ DATE:_________________
APPROVED BY: _______________________________

16. DATA SHEETS….continued

DATA SHEET 2 (Sheet 1 of 2)
ESC SYSTEM HARDWARE AND OPERATIONAL CHARACTERISTICS

VEHICLE MAKE/MODEL/BODY STYLE:____

NHTSA No.:________________________ TEST DATE:________________________

ESC SYSTEM IDENTIFICATION:
Manufacturer/Model ____

ESC SYSTEM HARDWARE (Check applicable hardware):
______ Electronic Control Unit ______ Hydraulic Control Unit
______ Wheel Speed Sensors ______ Steering Angle Sensor
______ Yaw Rate Sensor ______ Lateral Acceleration Sensor

List other components; ____

ESC SYSTEM OPERATIONAL CHARACTERISTICS:

System is capable of generating brake torques at each wheel ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

System is capable of determining yaw rate ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

System is capable of monitoring driver steering input ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

System is capable of estimating side slip or side slip derivation ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

16. DATA SHEETS....continued

DATA SHEET 2 (Sheet 2 of 2)
ESC SYSTEM HARDWARE AND OPERATIONAL CHARACTERISTICS

ESC SYSTEM OPERATIONAL CHARACTERISTICS (continued):

System is capable of modifying engine torque during ESC activation. _____ Yes (PASS)
_____ No (FAIL)

See information in Section 6*

System is capable of activation at speeds of 15 km/h (9.3 mph) and higher. _____ Yes (PASS)
_____ No (FAIL)

See information in Section 6*

System is capable of activation during the following driving phases (acceleration, deceleration, coasting, and during activation of ABS or traction control). ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

Vehicle manufacturer submitted documentation explaining how the ESC system mitigates understeer? ______ Yes (PASS)
______ No (FAIL)

See information in Section 6*

***** Include ESC descriptions; vehicle system and logic diagrams; copies of owner's manual pages' and other material as directed by the COTR in Section 6.

DATA INDICATES COMPLIANCE PASS/FAIL ____________

REMARKS:

RECORDED BY: ______________________________ DATE:_________________
APPROVED BY: ______________________________

16. DATA SHEETS....continued

DATA SHEET 3 (Sheet 1 of 5)
ESC MALFUNCTION AND OFF TELLTALES AND CONTROLS – Location, Labeling and Bulb Check (Effective on and after September 1, 2011)

VEHICLE MAKE/MODEL/BODY STYLE:______________________________________

VEHICLE NHTSA NO. _______________ TEST DATE:_________________

ESC Malfunction Telltale
Malfunction Telltale Location ____

Telltale is mounted inside the occupant compartment in front of and in clear view of the driver?
______Yes ______No (fail) If no, explain: ____________________________

Telltale is part of a common space? ______ Yes ______ No

Malfunction Telltale symbol or abbreviation required by FMVSS No. 101.

Or **ESC**

________Vehicle uses this symbol
________Vehicles uses this abbreviation

Note any words or additional symbols used.
____
____

"ESC OFF" Telltale (if provided)
"ESC OFF" Telltale Location ____

"ESC OFF" telltale is mounted inside the occupant compartment in front of and in clear view of the driver?
______Yes ______No (fail) If no, explain: ____________________________

Telltale is part of a common space? ______ Yes ______ No

16. DATA SHEETS....continued

DATA SHEET 3 (Sheet 2 of 5)
ESC MALFUNCTION AND OFF TELLTALES AND CONTROLS

"ESC OFF" Telltale symbol or abbreviation required by FMVSS No. 101.

Or **ESC OFF**

_______Vehicle uses this symbol
_______Vehicle uses this abbreviation

Note any words or additional symbols used.

____

____

Malfunction Telltale Lamp Function:
Identify position of ignition locking system when malfunction telltale illuminates.

☐ OFF/LOCK ☐ Between OFF/LOCK and ON/RUN

☐ ON/RUN ☐ Between ON/RUN and Start

Is telltale yellow in color? ______ Yes ______ No (fail)

Time telltale remains illuminated ______ seconds

Note: If telltale is part of common space, it is not required to illuminate during this check of lamp function.

Starter Interlock:
Does vehicle have any starter, transmission or other interlocks that affect operation of the Malfunction telltale lamp check functions? ______ Yes ______ No

If yes, describe the interlock feature:

____

____

16. DATA SHEETS....continued

DATA SHEET 3 (Sheet 3 of 5)
ESC MALFUNCTION AND OFF TELLTALES AND CONTROLS

"ESC OFF" Telltale Lamp Function:
Identify position of ignition locking system when "ESC OFF" telltale illuminates.

☐ OFF/LOCK ☐ Between OFF/LOCK and ON/RUN

☐ ON/RUN ☐ Between ON/RUN and Start

Is telltale yellow in color? ______ Yes ______ No (fail)

Time telltale remains illuminated ______ seconds

Note: If telltale is part of common space, it is not required to illuminate during the check of lamp function.

Starter Interlock:
Does vehicle have any starter, transmission or other interlocks that affect operation of the "ESC OFF" telltale lamp check functions? ______ Yes ______ No

If yes, describe the interlock feature:

____

____

ESC OFF Control Operational Check:
Is the vehicle equipped with a control whose sole purpose is to deactivate the ESC system? ______ Yes ______ No

"ESC OFF" Control identification symbol or abbreviation required by FMVSS No. 101.

Or **ESC OFF**

_______Vehicle uses this symbol
_______Vehicle uses this abbreviation

Note any words or additional symbols used.

____

____

16. DATA SHEETS....continued

DATA SHEET 3 (Sheet 4 of 5)
ESC MALFUNCTION AND OFF TELLTALES AND CONTROLS

Does the “ESC Off” telltale illuminate upon activation of the ESC off control?

______ Yes ______ No (fail)

If no, describe off control function:

____

____

Does the “ESC Off” telltale extinguish when the ignition is cycled from “On” (“Run”) to “Lock” or “Off” and then back again to the “On” (“Run”) position?

______ Yes ______ No (fail)

If no, describe the off control function:

____

____

Other System Controls that have an ancillary effect on ESC Operation:
List other controls (i.e. low speed off-road axle/transfer case):

____

____

Does the “ESC OFF” telltale illuminate upon activation of each control system listed above?

______ Yes ______ No

If no, describe off control function:

____

____

For electrical controls, does the “ESC OFF” telltale extinguish and remain extinguished when the ignition is cycled from “On” (“Run”) to “Lock” or “Off” and then back again to the “On” (“Run”) position?

______ Yes ______ No

If no, describe the off control function:

____

____

16. DATA SHEETS....continued

DATA SHEET 3 (Sheet 5 of 5)
ESC MALFUNCTION AND OFF TELLTALES AND CONTROLS

For mechanical controls, does the "ESC OFF" telltale extinguish after de-activation of mechanical control?

_____ Yes _____ No

If no, describe the off control function:

____

DATA INDICATES COMPLIANCE: PASS/FAIL ____________

REMARKS:

RECORDED BY:______________________________ DATE: __________
APPROVED BY:______________________________ DATE: __________

16. DATA SHEETS....continued

DATA SHEET 4 (Sheet 1 of 4)
VEHICLE AND TEST TRACK DATA

VEHICLE MAKE/MODEL/BODY STYLE:____

VEHICLE NHTSA NO. _______________ TEST DATE:_________________

Test Track Requirements: Test Surface Slope (0-1 %) ___________%

Peak Friction Coefficient (0.9) ___________

Full Fluid Levels: Fuel ______ Coolant _________ Other Fluids _____(specify)

Tire Pressures: Required; Front Axle________KPA Rear Axle_________KPA

Actual; LF_________ KPA LR_________KPA
RF_________ KPA RR_________KPA

Vehicle weight: GAWR Front____________KG GAWR Rear____________KG

Unloaded Vehicle Weight (UVW)

Front Axle_____________KG Right Front__________KG Left Front ____________KG
Rear Axle_____________KG Right Rear__________KG Left Rear ____________KG
Total UVW__________KG

UVW with Outriggers (only for MPVs, Trucks, Buses)

Calculated Baseline Weight (UVW+ 73 kg) ________________KG
Outrigger size required ("Standard" or "Heavy") ________________

Front Axle_____________KG Right Front__________KG Left Front ___________KG
Rear Axle_____________KG Right Rear__________KG Left Rear ____________KG
Total UVW w/Outriggers_______KG

Loaded Vehicle Weight

Front Axle_____________KG Right Front__________KG Left Front ____________KG
Rear Axle_____________KG Right Rear__________KG Left Rear ____________KG
Total Vehicle Weight__________KG

16. DATA SHEETS....continued

DATA SHEET 4 (Sheet 2 of 4)
VEHICLE AND TEST TRACK DATA

Center of Gravity: Point of reference location ________________________________

	Vehicle Loaded
x-distance (longitudinal)	___________cm
y-distance (lateral)	___________cm

Sensor Location with Respect to Center of Gravity:

	Inertial Sensing System	Ultra Sonic Sensors
x-distance	___________cm	___________cm
y-distance	___________cm	___________cm

Test Instrumentation/Equipment Installation Check List:

______ If outriggers are required, remove bumper assemblies.

Manufacture and install outrigger mounts.

Install outriggers and verify fasteners are all tightened. The initial clearance between the road surface and the bottom of the NHTSA outrigger skid pads shall be approximately 344 millimeters (13.5-inches) for the standard and heavy-duty outriggers. These distances shall be measured with the test vehicle at rest on a level surface.

Measure weight of vehicle with outriggers installed.

______ Remove steering wheel air bag and center console.

______ Manufacture, install and level inertial sensing system mounting plate. (Mounting system plate should be located as close as possible to the perceived vehicle CG.)

16. DATA SHEETS....continued

DATA SHEET 4 (Sheet 3 of 4)
VEHICLE AND TEST TRACK DATA

Test Instrumentation/Equipment Installation Check List (continued):

______ Install data acquisition system (DAS) computer with monitor and signal conditioning rack into front passenger seat.

______ Install inertial sensing system and run cables to DAS computer.

______ Install brake pedal force load cell and run cable to DAS computer.

______ Install ultrasonic distance sensors at vehicle longitudinal CG and run cables to DAS computer

______ Strap down and tighten DAS computer.

______ Run and connect main power line from vehicle battery to DAS computer.

______ Install speed sensor onto front outrigger or bumper assembly along centerline of vehicle.

______ Install speed sensor dashboard display and run cable to front outrigger.

______ Install steering controller and center on steering wheel.

______ Install and secure steering controller battery box.

______ Run cables connecting steering controller battery box to steering controller and DAS computer.

______ Power up DAS computer and verify all channels are activated.

______ Set up file names.

______ Set sample rate at 200Hz.

______ Calibrate dashboard speed display.

______ Calibrate ultrasonic distance sensors.

16. DATA SHEETS....continued

DATA SHEET 4 (Sheet 4 of 4)
VEHICLE AND TEST TRACK DATA

Test Instrumentation/Equipment Installation Check List (continued):

______ Calibrate inertial sensing system (6 channels).

______ Calibrate speed channel.

______ Calibrate steering controller encoder.

______ Verify brake signal detector shows change when pressure is applied.

______ Adjust Steering controller to trigger at the correct speed when the set speed function is used.

______ Determine weight of loaded vehicle with test driver.

______ Determine ballast required to achieve a total interior load of 168 kg.

______ Load ballast as determined in previous step and document weight of vehicle.

______ Determine loaded vehicle CG coordinates.

______ Adjust forward or aft placement of the ultrasonic measuring sensors to line up with the measured vehicle's CG longitudinal coordinate.

______ Measure coordinates of inertial sensing system sensor and ultrasonic distance measuring sensors relative to the vehicle CG coordinates.

TEST TRACK DATA MEETS REQUIREMENTS: YES/NO _______________
If no, explain: ____

REMARKS:

RECORDED BY:_____________________________________ DATE: ___________
APPROVED BY: _____________________________________

16. DATA SHEETS....continued

DATA SHEET 5 (Sheet 1 of 3)
BRAKE AND TIRE CONDITIONING

VEHICLE MAKE/MODEL/BODY STYLE:______________________________________

VEHICLE NHTSA NO. ______________

Measured Cold Tire Pressures: LF_________ KPA LR_________KPA
RF_________ KPA RR_________KPA

Wind Speed ________________ m/sec
(10m/sec (22mph) max for passenger cars; 5m/s (11mph) max. for MPVs and Trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) ________________ °C

Brake Conditioning Time;____________ Date;____________

56 km/h (35 mph) Brake Stops

Number of stops executed (10 required) ___________ stops

Observed deceleration rate range (.5g target) ___________ g

72 km/h (45 mph) Brake Stops

Number of stops executed (3 required) ___________ stops

Number of stops ABS activated (3 required) ___________ stops

Observed deceleration rate range ___________ g

72 km/h (45 mph) Brake Cool Down Period

Duration of cool down period (5 minutes min.) ___________ minutes

16. DATA SHEETS....continued

DATA SHEET 5 (Sheet 2 of 3)
BRAKE AND TIRE CONDITIONING

Tire Conditioning Series No. 1 Time:____________ Date:____________

Measured Tire Pressures: LF_________ KPA LR_________KPA
RF_________ KPA RR_________KPA

Wind Speed _________________ m/sec
(10m/sec (22mph) max for passenger cars; 5m/s (11mph) max. for MPVs and Trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) _________________ °C

30 meter (100 ft) Diameter Circle Maneuver				
Test Runs	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed
1-3	Clockwise	0.5-0.6		
4-6	Counterclockwise	0.5-0.6		

1 Hz 3 Cycle Sinusoidal Steering Maneuver to Determine Steering Wheel Angle For 0.5-0.6g Lateral Acceleration				
Test Runs	Vehicle Speed Km/h(mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1	56±2 (35±1)	30	0.5-0.6	
2	56±2 (35±1)		0.5-0.6	
3	56±2 (35±1)		0.5-0.6	
4	56±2 (35±1)		0.5-0.6	

Steering wheel angle that corresponds to a peak 0.5–0.6g lateral acceleration; _________degrees

1 Hz 10 Cycle Sinusoidal Steering Maneuver				
Test Runs	Vehicle Speed Km/h (mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1 - 3	56±2 (35±1)	(cycles 1-10)	0.5-0.6	
4	56±2 (35±1)	(cycles 1-9)	0.5-0.6	
		(cycle 10)*	NA	

* The steering wheel angle used for cycle 10 should be twice the angle used for cycles 1-9.

16. DATA SHEETS....continued

DATA SHEET 5 (Sheet 3 of 3)
BRAKE AND TIRE CONDITIONING

Tire Conditioning Series No. 2 Time:____________ Date:____________

Measured Tire Pressures: LF_________ KPA LR_________KPA
RF_________ KPA RR_________KPA

Wind Speed _________________ m/sec
(10m/sec (22mph) max for passenger cars; 5m/s (11mph) max. for MPVs and Trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) _________________ °C

30 meter (100 ft) Diameter Circle Maneuver				
Test Runs	Steering Direction	Target Lateral Acceleration (g)	Observed Lateral Acceleration (g)	Observed Vehicle Speed
1-3	clockwise	0.5-0.6		
4-6	counterclockwise	0.5-0.6		

1 Hz 3 Cycle Sinusoidal Steering Maneuver to Determine Steering Wheel Angle For 0.5-0.6g Lateral Acceleration				
Test Runs	Vehicle Speed Km/h (mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1	56$\pm$2 (35$\pm$1)	30	0.5-0.6	
2	56$\pm$2 (35$\pm$1)		0.5-0.6	
3	56$\pm$2 (35$\pm$1)		0.5-0.6	
4	56$\pm$2 (35$\pm$1)		0.5-0.6	

Steering wheel angle that corresponds to a peak 0.5–0.6g lateral acceleration; _________degrees

1 Hz 10 Cycle Sinusoidal Steering Maneuver				
Test Runs	Vehicle Speed (mph)	Steering Wheel Angle (degrees)	Target Peak Lateral Acceleration (g)	Observed Peak Lateral Acceleration (g)
1 - 3	56$\pm$2 (35$\pm$1)	(cycles 1-10)	0.5-0.6	
4	56$\pm$2 (35$\pm$1)	(cycles 1-9)	0.5-0.6	
		(cycle 10)*	NA	

* The steering wheel angle used for cycle 10 should be twice the angle used for cycles 1-9.

REMARKS:

RECORDED BY:_____________________________________ DATE: ___________
APPROVED BY: _____________________________________ DATE: ___________

16. DATA SHEETS....continued

DATA SHEET 6 (1 of 2)
SLOWLY INCREASING STEER (SIS) MANEUVER

VEHICLE MAKE/MODEL/BODY STYLE:_______________________________________

VEHICLE NHTSA NO. _______________ TEST DATE:_________________

Measured Tire Pressures: LF_________ KPA LR_________KPA
RF_________ KPA RR_________KPA

Wind Speed _________________ m/sec
(10m/sec (22mph) max for passenger cars; 5m/s (11mph) max. for MPVs and Trucks)

Ambient Temperature (7°C (45°F) - 40°C (104°F)) _________________ °C

Preliminary Left Steer Maneuver:
Lateral Acceleration measured at 30 degrees steering wheel angle ($a_{y,30\ degrees}$)
$a_{y,30\ degrees}$ =_____________g

Assuming a linear relationship the following ratio should be used to calculate the steering wheel angle at .55g.

$$\frac{30\,\text{degrees}}{a_{\text{y,30 degrees}}} = \frac{\delta_{SIS}}{0.55\,\text{g}}$$

δ_{SIS} = ____________ degrees

Steering Wheel Angle at Corrected 0.3 g Lateral Acceleration:

Maneuver #	Initial Steer Direction	Time Clock (5 min max between runs)	Steering Wheel Angle to nearest 0.1 degree (degrees)
1	Left		
2	Left		
3	Left		
1	Right		
2	Right		
3	Right		

16. DATA SHEETS....continued

DATA SHEET 6 (2 of 2)
SLOWLY INCREASING STEER (SIS) MANEUVER

Average Overall Steering Wheel Angle:

$\delta_{0.3\ g,\ overall} = (|\delta_{0.3\ g,\ left\ (1)}| + |\delta_{0.3\ g,\ left\ (2)}| + |\delta_{0.3\ g,\ left\ (3)}| + \delta_{0.3\ g,\ right\ (1)} + \delta_{0.3\ g,\ right\ (2)} + \delta_{0.3\ g,\ right\ (3)})$ / 6

$\delta_{0.3\ g,\ overall}$ = _____________ degrees
[to nearest 0.1 degree]

REMARKS:

RECORDED BY:_____________________________________ DATE: ___________

APPROVED BY: ____________________________________ DATE: ___________

16. DATA SHEETS....continued

DATA SHEET 7 (1 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

VEHICLE MAKE/MODEL/BODY STYLE:_______________________________________

VEHICLE NHTSA NO. ______________ TEST DATE:_________________

Tire conditioning completed ______ Yes ______ No
ESC system is enabled ______ Yes ______ No
On track calibration checks have been completed ______ Yes ______ No
On track static data file for each sensor obtained ______ Yes ______ No

Overall steering wheel angle ($\delta_{0.3\text{ g, overall}}$) ________________ degrees

Lateral Stability Test Series No. 1 – Counterclockwise Initial Steer Direction

Maneuver #	Clock Time (5 min max between runs)	Commanded Steering Wheel Angle[1] (degrees)		Yaw Rates (degrees/sec)			YYR at 1.0 sec after COS [< 35%]		YYR at 1.75 sec after COS [< 20%]	
		Scalar	Angle	$\dot{\psi}_{Peak}$	$\dot{\psi}_{1.0sec}$	$\dot{\psi}_{1.75sec}$	%	Pass/Fail	%	Pass/Fail
1		1.5* $\delta_{0.3\text{ g}}$								
2		2.0* $\delta_{0.3\text{ g}}$								
3		2.5* $\delta_{0.3\text{ g}}$								
4		3.0* $\delta_{0.3\text{ g}}$								
5		3.5* $\delta_{0.3\text{ g}}$								
6		4.0* $\delta_{0.3\text{ g}}$								
7		4.5* $\delta_{0.3\text{ g}}$								
8		5.0* $\delta_{0.3\text{ g}}$								
9		5.5* $\delta_{0.3\text{ g}}$								
10		6.0* $\delta_{0.3\text{ g}}$								
11		6.5* $\delta_{0.3\text{ g}}$								
12										
13										
14										
15										
16										

1. Maneuver execution should continue until a steering wheel angle magnitude factor of 6.5*$\delta_{0.3\text{ g, overall}}$ or 270 degrees is utilized, whichever is greater provided the calculated magnitude of 6.5*$\delta_{0.3\text{ g, overall}}$ is less than or equal to 300 degrees. If 6.5*$\delta_{0.3\text{ g, overall}}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of 0.5*$\delta_{0.3\text{ g, overall}}$ without exceeding the 270 degree steering wheel angle. If the highest calculated multiple of 0.5*$\delta_{0.3\text{ g, overall}}$ falls within the range of 260 - 270 degrees the final maneuver should be conducted at that angle, otherwise, the final maneuver should be conducted at the 270 degree steering wheel angle.

16. DATA SHEETS....continued

DATA SHEET 7 (2 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

LATERAL STABILITY TEST SERIES NO. 2 – Clockwise Initial Steer Direction

Maneuver #	Clock Time (5 min max between runs)	Commanded Steering Wheel Angle[1] (degrees)		Yaw Rates (degrees/sec)			YYR at 1.0 sec after COS [< 35%]		YYR at 1.75 sec after COS [< 20%]	
		Scalar	Angle	$\dot{\psi}_{Peak}$	$\dot{\psi}_{1.0sec}$	$\dot{\psi}_{1.75sec}$	%	Pass/Fail	%	Pass/Fail
1		1.5* $\delta_{0.3\,g}$								
2		2.0* $\delta_{0.3\,g}$								
3		2.5* $\delta_{0.3\,g}$								
4		3.0* $\delta_{0.3\,g}$								
5		3.5* $\delta_{0.3\,g}$								
6		4.0* $\delta_{0.3\,g}$								
7		4.5* $\delta_{0.3\,g}$								
8		5.0* $\delta_{0.3\,g}$								
9		5.5* $\delta_{0.3\,g}$								
10		6.0* $\delta_{0.3\,g}$								
11		6.5* $\delta_{0.3\,g}$								
12										
13										
14										
15										
16										

1. Maneuver execution should continue until a steering wheel angle magnitude factor of 6.5*$\delta_{0.3\,g,\,overall}$ or 270 degrees is utilized, whichever is greater provided the calculated 6.5*$\delta_{0.3\,g,\,overall}$ is less than or equal to 300 degrees. If 6.5*$\delta_{0.3\,g,\,overall}$ is less than 270 degrees maneuver execution should continue by increasing the steering wheel angle magnitude by multiples of 0.5*$\delta_{0.3\,g,\,overall}$ without exceeding the 270 degree steering wheel angle. If the highest calculated multiple of 0.5*$\delta_{0.3\,g,\,overall}$ falls within the range of 260 - 270 degrees the final maneuver should be conducted at that angle, otherwise, the final maneuver should be conducted at the 270 degree steering wheel angle.

During execution of the sine with dwell maneuvers were any of the following events observed?

Rim-to-pavement contact ______ Yes ______ No
Tire debeading ______ Yes ______ No
Loss of pavement contact of vehicle tires ______ Yes ______ No
Did the test driver experience any vehicle loss of control or spinout? ______ Yes ______ No

If "Yes" explain the event and consult with the COTR. ______________________
____
____

16. DATA SHEETS….continued

DATA SHEET 7 (3 of 3)
VEHICLE LATERAL STABILITY AND RESPONSIVENESS

Responsiveness – Lateral Displacement

Maneuver #	Initial Steer Direction	Commanded Steering Wheel Angle ($6.5*\delta_{0.3\ g,\ overall}$ or greater)		Lateral Acceleration at 1.07 seconds after BOS[1] (m/sec²)		Calculated Lateral Displacement[2]	
		Scalar	Angle (degrees)	Measured	Corrected	Distance (m)	Pass/Fail
	Counter Clockwise	$5.0*\delta_{0.3\ g}$					
	Counter Clockwise	$5.5*\delta_{0.3\ g}$					
	Counter Clockwise	$6.0*\delta_{0.3\ g}$					
	Counter Clockwise	$6.5*\delta_{0.3\ g}$					
	Counter Clockwise						
	Counter Clockwise						
	Counter Clockwise						
	Counter Clockwise						
	Clockwise	$5.0*\delta_{0.3\ g}$					
	Clockwise	$5.5*\delta_{0.3\ g}$					
	Clockwise	$6.0*\delta_{0.3\ g}$					
	Clockwise	$6.5*\delta_{0.3\ g}$					
	Clockwise						
	Clockwise						
	Clockwise						
	Clockwise						

1.Measured Lateral Accelerations are corrected for sensor location CG offset and vehicle body roll.
2. For passenger cars lateral displacement should be $\geq$ 1.83 m (6 ft); For MPVs and trucks lateral displacement should be $\geq$ 1.52 m (5ft).

DATA INDICATES COMPLIANCE: PASS/FAIL ____________

REMARKS:

RECORDED BY:_______________________________; DATE:_________________

APPROVED BY:_______________________________; DATE:_________________

16. DATA SHEETS….continued

DATA SHEET 8
MALFUNCTION WARNING TEST

VEHICLE MAKE/MODEL/BODY STYLE:_______________________________________

VEHICLE NHTSA NO. ______________ TEST DATE:_________________

CHECK MALFUNCTION TELLTALE BULB CHECK FUNCTION:
Before simulating an ESC system malfunction activate the vehicle ignition locking system and verify telltale illuminates for the bulb check and then extinguishes.
_______Yes _No

Describe telltale label (until 9/1/2011, can be ABS telltale) ________________________

METHOD OF MALFUNCTION SIMULATION:
Describe method of malfunction simulation:_____________________________________

____

MALFUNCTION TELLTALE ILLUMINATION:
Telltale illuminates and remains illuminated after ignition locking system is activated and if necessary the vehicle is driven at least 2 minutes ______ Yes ______No

Time for telltale to illuminate after ignition system is activated and vehicle speed of 48± 8 km/h (30± 5mph) is reached.
______ Seconds (must be within 2 minutes) ______ Pass ______ Fail

Cycle ignition locking system and start the vehicle's engine. Verify that the malfunction telltale illuminates and stays illuminated. ______ Yes ______No

After the ESC system is restored to normal operation verify that the telltale does not remain illuminated. ______ Yes ______No

DATA INDICATES COMPLIANCE: PASS/FAIL ____________

REMARKS:
RECORDED BY:_____________________________; DATE:________________

APPROVED BY:_____________________________; DATE:________________

17. FORMS

LABORATORY NOTICE OF TEST FAILURE TO OVSC

FMVSS NO.: ______126________ TEST DATE:________________________

LABORATORY:____

CONTRACT NO.: ________________________ DELV. ORDER NO.:_________________

LABORATORY PROJECT ENGINEER'S NAME:____________________________________

TEST SPECIMEN DESCRIPTION:____

VEHICLE NHTSA NO.: ____________ VIN:______________________________________

MFR:____

TEST FAILURE DESCRIPTION: ____

____

____

____

FMVSS REQUIREMENT, PARAGRAPH S _________:

____

____

____

NOTIFICATION TO NHTSA (COTR): ____

DATE: _______________ BY: ____

REMARKS:

17. FORMS....Continued

MONTHLY TEST STATUS REPORT
FMVSS 126
DATE OF REPORT:

NO.	VEHICLE NHTSA NO., MAKE & MODEL	COMPLIANCE TEST DATE	PASS/ FAIL	DATE REPORT SUBMITTED	DATE INVOICE SUBMITTED	INVOICE PAYMENT DATE
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

17. FORMS....Continued

MONTHLY VEHICLE STATUS REPORT
FMVSS 126
DATE OF REPORT:

NO.	VEHICLE NHTSA NO., MAKE & MODEL	DATE OF DELIVERY	ODOMETER READING	TEST COMPLETE DATE	VEHICLE SHIPMENT DATE	ODOMETER READING
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						